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No. 3

Economic Intelligence Report

SOVIET TARGETS FOR TECHNICAL ADVANCES IN THE ECONOMY, 1959–65: A GENERAL CONSIDERATION

CIA/RR ER 62–42

December 1962

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FOREWORD

This report contains the general and summary sections of a more detailed project in which are surveyed the directive plans for technical advance in the nonagricultural sectors of the Soviet economy. [redacted] 50X1

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The project as a whole is designed (1) to summarize the plans for technical advance in the nonagricultural sectors of the Soviet economy, (2) to provide a comprehensive basis for comparing the plans of the individual branches with one another and with the total program, and (3) to examine the requirements for capital and labor implicit in the plans. It is hoped that the various programs may be placed into some perspective so that "glamorous" programs with minor economic significance are not given undue weight and so that "unglamorous" programs with major economic significance are not ignored. In many respects the project is intended to raise questions to be answered, hopefully in subsequent reports, either of this Office or of the many other groups and individuals engaged in studying the Soviet economy.

The attention of the reader is directed to the fact that this report is a survey of Soviet plans and intentions prepared as a preliminary step to future evaluation of the prospects for the Soviet plans. The summarization of the Soviet plans as found herein should not be interpreted as an evaluation that the plans will be fulfilled, for the Soviet programs face serious problems arising in the processes of planning, administration, and implementation.

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SOVIET TARGETS FOR TECHNICAL ADVANCES IN THE ECONOMY, 1959-65: A GENERAL CONSIDERATION*

Summary

The USSR plans to achieve an increase of 80 percent in industrial production during the Seven Year Plan (1959-65) with an increase of about 20 percent in the employment of industrial wageworkers. Although some part of the increased labor productivity is scheduled to result from better management -- that is, less interruption of work because of faulty uneven flow of material and power -- the major share of the increase is to come from the application of better production techniques or advanced technology. The advances in applied industrial technology must be related to the low average level existing in the base period. The USSR claims for 1959 an industrial labor productivity of 40 to 50 percent of that in the US. Because of differing methods of estimating the value added in the industries of the two countries, the Soviet worker is to be credited with producing little more than one-third of the product of his US counterpart. In any event, measured in terms of labor productivity, the average level of Soviet industrial technology lags far behind that of the US, leaving much room for technological advances without the introduction of any technology new either to the USSR or to the West.

Previous Soviet preoccupation with increasing the total industrial output, together with a limited capacity to supply the needed capital equipment, has resulted in a failure to retire otherwise obsolete plant and equipment. In other cases, efficient main-process equipment has been installed but not the labor-saving materials handling and other auxiliary equipment. In other words, scarcity of capital and an abundance of labor supply, coupled with a high demand for the product, have made profitable the continued operation of outmoded plant and equipment in spite of the wide discrepancy in efficiency of the use of labor compared with plants of more recent design.

During the Seven Year Plan period the relative availability of the factors of production will change markedly. If the investment program of the Seven Year Plan is carried out, the fixed capital of industry will increase by more than 125 percent while production is planned to increase 80 percent and the labor force by about 20 percent. Capital per worker is planned almost to double while capital per unit of output is planned to increase by one-fourth. It is apparent that, for

* The estimates and conclusions in this report represent the best judgment of this Office as of 1 December 1962.

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planning purposes at least, large infusions of labor are not available for transfer into industry from agriculture. Rather than make the investment in agriculture that would permit shifting even more workers to industry, the Soviet planners have chosen to make a sizable investment in reducing the labor requirement per unit of output in industry.

The lesser weight assigned to the growth of the labor force in the Seven Year Plan may be illustrated by a comparison with recent trends. During 1959-65 the average annual increase in industrial employment of wageworkers is planned to be only 2 to 3 percent; in industrial fixed capital, more than 12 percent; and in output, almost 9 percent. The corresponding average annual increases realized during 1956-60 were 5 percent, 10 percent, and 10 percent, respectively. During 1959 and 1960, industrial employment, industrial fixed capital, and industrial output all grew at rates greater than planned.

The Soviet labor force in industry in 1958 included 16.3 million wageworkers. Given the planned increase in output, if there were no increase in annual labor productivity, more than 29 million workers would be required to achieve the planned output in 1965. Because of the planned increases in labor productivity, 19 million to 20 million wageworkers are expected to suffice in 1965.

Planned investment in Soviet industry during the period of the Seven Year Plan is 104 billion rubles.* It is estimated that 15.7 billion rubles of investment are required to replace assets physically retired during the period. A total of 64.3 billion rubles in addition would have been required to expand fixed assets proportionately to output for each of the 12 industrial branches included. There is then a residual investment of 24.0 billion rubles in excess of that required if production in 1965 were to be achieved with the same capital-labor factor mix as existed in 1958. One might say that the Soviet planners expect to save about 10 million workers by investing 24 billion rubles, or about 2,300 rubles per worker displaced, but unfortunately an industry-by-industry look quickly dispels the notion. The excess investment ranges from a negative 3,900 rubles per worker displaced in the electric power industry to 81,000 rubles in the oil and gas industry. The wide disparity calls for further refinement of the data before conclusions can be reached. For instance, investment data for oil and gas include a substantial amount for construction of pipelines that displaces railroad workers, not oil and gas workers.

* Ruble values in this report are given in new rubles established by the Soviet currency reform of 1 January 1961. A nominal rate of exchange based on the gold content of the respective currencies is 0.90 ruble to US $1. This rate, however, should not be interpreted as an estimate of the equivalent dollar value of similar US goods or services.

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Of perhaps more pertinence to the increase in Soviet labor productivity is the planned increase in industrial fixed assets per worker from 4,290 rubles in 1958 to 8,310 rubles in 1965. There is again, however, a wide and growing disparity between industries in assets per worker. In 1958 the electric power industry had 29 times the 1,300 rubles per worker of light industry. By 1965 it will have 32 times the 2,130 rubles per worker of light industry but will be surpassed by the oil and gas industry, which is planned to have 40 times the capital per worker of light industry.

Much of the improvement in Soviet labor productivity will come from investment in mechanization -- that is, the provision of some tool or implement to reduce the physical effort required of the worker. In mid-1959, almost one-half (47 percent) of the industrial workers performed significant amounts of manual labor. Achievement of the goal of the Seven Year Plan would not entirely eliminate workers performing manual labor by 1965. By 1970, however, most of the feasible reductions of manual labor will have been made. The continued growth of labor productivity to achieve the goals of 1980 will depend, after 1970, on the introduction of new technologies more sophisticated than the mere reduction of manual labor. At the same time, unless capital investment is to grow inordinately, the Soviet planners will need to find technologies that are capital-saving as well as labor-saving. With respect to automation the period of the Seven Year Plan may well be regarded as a period of experimentation and intensive application in selected plants to prepare for the broader applications to be made during the 1970's.

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I. Background

A. State-of-the-Art

Any consideration of Soviet targets for technical advances must take some account of the state-of-the-art in the application of industrial technology. To do so completely would require an examination shop by shop, plant by plant, and industry by industry far beyond the capacities of this report.* In this report, there will be illustrated only those general characteristics that have a bearing on subsequent attempts to analyze the Soviet plans for technical advances in state industry.**

As measured by labor productivity, the level of Soviet industrial technology in 1958 was low. The Soviet industrial worker in that year produced less than the claimed 40 to 50 percent 2/ of the level of output of a US industrial worker -- perhaps as little as one-third as much. Not only was the average low, but the application of technology was very uneven as between industries and also as between plants in an industry and even as between shops in a plant. Perhaps the greatest contrast is typified by an old Soviet woman sweeping the street with a twig broom in preparation for a parade of guided missiles. The USSR without doubt has demonstrated great technological skills that have been preponderantly applied to military production rather than to satisfying the wishes of consumers -- hence the complaints of the textile industry of low productivity resulting from the continued use of spinning and weaving equipment more than 40 years old. In the iron and steel industry in the Urals region not far from Magnitogorsk, in the largest steel mill in the world, small crude plants using charcoal rather than coke, which were typical of the early Tsarist industry, are still in operation. Even in the larger steel mills where output of pig iron per yard of blast-furnace capacity is equal to that in the US, the total employment of labor per ton of steel produced is about two and a half times as high.

It would appear, therefore, that in spite of the failure in Soviet cost accounting to make adequate allowances for the cost of capital, the scarcity of capital has forced the continued use of fixed assets that in a competitive sense are obsolete. Or, put another way, the Soviet preoccupation with growth of output has been such that the management could not afford the luxury of shutting down inefficient units. The capability

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** In this report, references to "industry" pertain to state industry only and exclude handicraft and cooperative industry.

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of adding new units of capacity was so limited that each new unit had to be planned as a net addition to capacity in order to satisfy more nearly the total demand for the end product. In terms of marginal analysis the effective demand for product has been so great as to tolerate the continued operation of old and technologically inefficient plant and equipment at the relatively low wage rates that have prevailed.

The continued operation of technologically less efficient equipment has a number of implications for an understanding of Soviet claims and plans for technological advances in industry. First, a clear distinction needs to be made between the average level of technology and the marginal capability. The latter can be improved only by research and development at home or abroad leading to new techniques of production. The average industrial technology, on the other hand, can be greatly increased, with no increase at the margin, simply by replacing obsolete processes with already known improvements or by making all new additions at the upper end of the range of technologies represented in the industry. It is with the average technology measured in terms of the average labor productivity that Soviet plans for the introduction of new technology in industry are concerned. Therefore, it is impossible to jump from the planned improvement in the average level of technology applied in an industry to any conclusion about the scientific achievements of the USSR.

Dealing with the average technology measured in terms of labor productivity, it is impossible to isolate such marginal considerations as "How much was the USSR willing to invest in order to make the last reduction in labor force requirements?" Yet the fact that the measurement of the relative value of capital and labor is not so refined need not cause too much concern, because an economy is being dealt with in which the values of capital equipment, of labor, and of their product are all determined independently of the relation of supply to effective demand. Limitations of supply have often not been reflected in the price but rather in some administered system of allocations. The pragmatic choice to keep scarce capital equipment in use long after it would competitively have been obsolete has already been commented on. Conversely, in the case of labor, up to now it has been the practice to divert additional labor from agriculture to meet the needs of industry. These actions recognize, as the Soviet price structure does not, the very real scarcity of capital and the relative abundance of labor. During the period of the Seven Year Plan these relationships will be changing rapidly. Capital assets in industry are planned to double and more while the amount of labor planned to be diverted from agriculture to industry is very modest. Although wages and prices of capital equipment may change during the period, it will not be in recognition of their changing availability. At best, in the subsequent analysis, only some general evaluations of the Soviet plans for introducing new technology into industry can be arrived at, and for this purpose an indication of some changes in the average level of technology will suffice.

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B. Objectives of Soviet Technical Development

Soviet political theoreticians see the Soviet economy as being in a stage of evolution toward the creation of the material-technical basis necessary to the final achievement of Communism. 3/ The achievement of this basis is to be characterized by the prevalence of large-scale production founded on electrification; full automation of production; the large-scale use of chemical processes; the use of atomic energy for economic purposes; and the development of workers who are widely educated, highly qualified, and culturally advanced. In slightly more pragmatic terms, the USSR links the achievement of this high level of technology to victory in the race to overtake and surpass the "capitalistic countries" in per capita production.

Although it would not be fruitful to dwell now on the ephemeral visions of the Communist future, three conclusions can be drawn from them. First, technical change is viewed as a necessary part of the evolution of the Soviet economy. Second, technical change is a proper area for competition with the Western economies. Finally, technical change is viewed as somehow related to the development of Communist man -- in other words, it has significant sociopolitical implications.

If technical change is inevitable, indeed essential, then the specific programs for the development of the Soviet economy must attempt to control and manipulate such change. Yet, because technical change has elements of randomness and of response to circumstances that cannot be readily foreseen, there is a large element of unpredictability.

On the positive side, there is evidence from research that technical progress is related to the resources devoted to research and development, to the skills and attitudes of the people, to the growth of capital investment and the structure of investment, to the nurturing of a social and institutional environment favorable to productive changes, to the availability and the dissemination of new techniques, and to the criteria used to judge successful management. By careful attention to all these factors, the leadership of the USSR hopes to create conditions in which technical progress can flourish.

Recognition that the USSR is making a conscious effort in this direction should not be a prejudgment that the effort will succeed. There are many areas where conflicts in policy may inhibit timely choices favorable to technological development. First, the concern of the regime for economic growth is more obvious than are the objectives of that growth, and certainly to many within the USSR will occur a doubt as to the desirability of growth for growth's sake. Second, the preoccupation with establishing the material-technical basis of Communism is more obvious than the shape and nature of the new Communist society that is

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being planned for. Third, there are obvious areas of conflict in the fact that changes in the economic structure imply changes in effective power (the command over resources) to the possible detriment of one group and to the benefit of another.

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II. Technical Change and Industrial Employment

A. General Plans for Change in Productivity, 1959-65

In the context of Soviet plans, technical advances are viewed in the form of technical programs that change the efficiency of inputs and, more particularly, that change labor productivity. Technical change so defined would include the effects of structural change in the economy (as the shift in the fuel base); economies of scale; improvements in education; changes in the mix of final products; changes in economic institutions and in the organization of the economy; improvements in the utilization of labor; and, finally, technological changes in the production function (that is, changes in the alternative ways of performing production processes).

In economic analysis these topics usually can be simplified to three major groups: changes in technological coefficients and production functions, changes in input prices, and changes in efficiency because of economies of scale, but the Soviet source material usually does not make such distinctions, and in this report it will not be possible to make these distinctions. As a consequence, it is necessary to focus on the plans for increasing labor productivity and on the plans for investment that support this program.

It is a leading objective in Soviet plans for technical advances that labor productivity be increased significantly, and achievement of this objective is a major consideration in the detailed formulation of actual programs. For this reason, it is of importance to consider the plans for increasing labor productivity even though an important share of such increase can be obtained without qualitative changes in equipment or processes. Labor productivity can change in several ways without representing a change in a production function -- as the result of economies of scale or as the result of changes in the cost of labor relative to capital that alter the optimal combination of capital and labor among the available production alternatives. Such changes in factor cost, however, are rarely instantaneous, and both factor costs and production functions are likely to change during the passage of time.

During the period of the Seven Year Plan the relative availability of the factors of production will change markedly. If the investment program of the Seven Year Plan is carried out, the fixed assets of industry will increase by more than 125 percent while the labor force is planned to increase about 20 percent and production is planned to increase 80 percent. Capital per worker is planned almost to double

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while capital per unit of output is planned to increase by one-fourth. It is apparent that, for planning purposes at least, large infusions of labor were not available for transfer into industry from agriculture. Rather than make the investment in agriculture that would permit shifting more workers to industry, the Soviet planners chose to make a sizable investment in reducing the labor requirement per unit of output in industry.

The lesser weight assigned to the growth of the labor force in the Seven Year Plan may be illustrated by a comparison with recent trends. During 1959 through 1965 the average annual increase in industrial employment of wageworkers is planned to be only 2 to 3 percent; in industrial fixed assets, more than 12 percent; and in output, almost 9 percent. The corresponding average annual increases realized during 1956 through 1960 were 5 percent, 10 percent, and 10 percent, respectively. During 1959 and 1960, the first 2 years of the Seven Year Plan, industrial employment, industrial fixed capital, and industrial output all grew at rates greater than planned.

B. Plans for Reductions in the Workweek

Analysis of changes in annual labor productivity must recognize the complications introduced by changes in the length of the workweek. From 1959 through 1961, there was a reduction in the average workweek in Soviet industry from approximately 44 hours to approximately 40 hours. Although it was intended that the various industries begin transition to a 35-hour workweek during 1964-68, the new Twenty Year Plan states only that the transition to the workweek of 34 to 36 hours will be effected "during the coming 10 years" (that is, by 1970). 4/ This vagueness in commitment makes it unwise to count on any further reduction in the workweek by 1965.

For this reason, and for the further reason that the directive plans have been prepared primarily on the basis of requirements for the labor force as derived from plans for changes in annual labor productivity, the analysis in this report has been conducted in terms of the plans governing annual productivity. On the basis of the reduction in the workweek already accomplished, the targets for changes in labor productivity on an hourly basis in 1965 would imply an increase relative to 1958 almost one-third greater than the targets on an annual basis.

C. Labor Force Requirements, 1965 and 1980

In terms of the wageworkers and excluding the salaried personnel, the Soviet economy in 1958 employed 16.3 million in industry, 3.9 million in construction, 2.0 million in railroad transport, and 0.7 million in

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communications. 5/ Without gain in productivity (in annual terms), the requirements for employment in 1965 would be as follows: for industry, more than 29 million; for construction, 6.3 million; for railroad transport, 2.8 million; and for communications, 1.1 million. Achievement of the targets for annual gain in productivity would permit reduction of these figures by about 10 million industrial wageworkers, 2.4 million construction wageworkers, 0.7 million railroad wageworkers, and 0.3 million communications wageworkers.

The industrial labor requirements stated in the foregoing paragraph and subsequently throughout this report are derived from a branch-by-branch application of the planned increase in production and in productivity to the 1958 labor force. Unfortunately the data on labor productivity and the planned increase in production by branch of industry [redacted] may or may not precisely equate to the unknown numbers used by the Soviet authorities in the preparation of the Seven Year Plan. In the case of industrial labor productivity the Seven Year Plan announcement set a goal of an increase of 45 to 50 percent. The computations by branch of industry shown in Table 1* imply an increase of 55 percent. This discrepancy, which is small enough not to affect the validity of any conclusions that might otherwise be drawn from this preliminary survey of Soviet plans for the introduction of new technology, can arise in whole or in part from a number of variations, among which are the following: 50X1

1. Data on productivity by branch of industry are from sources subsequent to the plan announcement and may in some cases represent higher goals than those on which the original plan announcements were predicated;

2. For several branches of industry, data on productivity either have been estimated or perhaps have been rounded in the official announcement;

3. In some cases the measure of increase in productivity for a branch of industry may have been based on a definition of the labor force different from that used in preparation of the plan.

Had the total number of workers required in industry increased in proportion to the index of increase in production of the plan announcement, the 1965 labor force requirement for industry would have been 29.3 million workers rather than 29.5 million, with no increase in productivity. The labor saving in industrial employment resulting from the midpoint of the announced increase in productivity of 45 to 50 percent would have been only 9.4 million. It would be the rarest of coincidences, however,

* P. 15, below.

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if the labor requirement without change in productivity rose exactly in proportion to the index of change in the gross value of product. The only conditions that would satisfy such a result would be an exact equality in output per worker in each branch of industry or a constant rate of increase in gross value of output for each branch of industry. Neither of these conditions appears to be true either for the base period or for 1965. Differential rates of change in labor productivity by branch of industry and its correlation with the introduction of new technology through investment are the very subject toward which this study is a small beginning. The differential in planned rates of growth between heavy and light industries is already too well known to require comment. Essentially it is to be expected that the weight of any branch of industry in the total industrial labor force will differ from its share in total gross value of product. With differential rates of growth by branch of industry the total gross value of production will increase at a rate to some degree different from the increase in total labor requirements even though the labor requirements expand proportionately to production in each branch of industry.

As indicated above, when calculated by branch of industry the increase in labor force requirements with no change in productivity is 81 percent rather than the 80 percent indicated by the announced planned increase in total gross value of output. This apparent high degree of correlation is partly to be expected because the USSR gives a high weight to labor cost in the value of product. On the other hand, the correlation may not be so close as it appears. The indexes of increase in production during the period of the Seven Year Plan are the best estimates of responsible branches in this Office and are based on numerous Soviet announcements. Not all of the announcements, however, are linked to the original plan. In some cases the plan announcement, like that for the coal industry, gives a planned increase in tonnage to be produced without regard to differential price or quality or place values. Furthermore, in the case of gross value of industrial output, there is no base period total or breakdown by branch of industry against which indexes of growth can be tested to determine how far the estimates by branch of industry differ from the increase of 80 percent of the announced plan.

In spite of the lack of Soviet value of output data, which would permit a much more accurate calculation of labor productivity, capital output, and increase in production, it is believed that the indexes of production and the data on labor productivity available will permit of meaningful analysis at least for the purpose of determining the advisability of expending effort on future refinement. As can not be repeated too often, an estimate or calculation by branch of industry that appears to differ from the plan announcement does not mean that the plan has been revised any more than the statement of a plan figure means

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that it will be accomplished. Rather, the discrepancies are the result of the inability, [redacted] to reconstruct fully the Soviet calculations in order to make a matrix consistent in precise detail with all parts of the Seven Year Plan, if indeed the Soviet authorities themselves had such a matrix. 50X1

With full recognition that the data by branch of industry may be only a close approximation of the information on which the Soviet authorities based the Seven Year Plan announcement, the analysis can be continued as long as the basing of major conclusions on minor variations in the numbers is avoided.

The rapid growth planned for industrial output will permit an increase in industrial employment in spite of the vast labor savings created by the increase in labor productivity, planned savings that will amount to about 1.5 million industrial wageworkers as the annual average during 1959-65.

During 1948-60, in the US, the increase in productivity of production workers in industry has been more rapid than increases in industrial output, and the number of production workers has declined from 13.9 million workers in 1947 to 13.2 million workers in 1960.* Given an increase in output amounting to 28 percent in mining, 63 percent in manufacturing, and 187 percent in gas and electric utilities and weighting these indexes by employment in 1947, the industrial employment required for 1960 would have been more than 23 million workers in the absence of increases in productivity. 6/ Hence the total labor saving during the 13 years from 1947 through 1960 totaled almost 10 million in US industry, for an average annual saving of some 760,000.

The Soviet Seven Year Plan schedules a rate of increase in annual labor productivity averaging 5.5 to 6.0 percent, somewhat less than the average rate of 7.0 percent during the 5 years 1954 through 1958.** Indeed, the average annual increase realized during the 3 years 1959 through 1961 did fall to 5.7 percent. This decline, however, may be attributed in large part to the effect of reduction in the workweek. Evidently the Soviet planners expect a resumption of high annual rates. The Twenty Year Plan would require an average annual increase in labor productivity of more than 7 percent during 1961 through 1970 and of

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* For rough comparability with the Soviet data, the data include only production workers, not total employment, in mining, in manufacturing, and in the gas and electric utilities.

** These rates are based on official Soviet data and tend to be biased upward in relation to rates calculated using [redacted] Western methods of calculation. 50X1 50X1

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7 to 8 percent during 1971 through 1980. The longer term plans, however, are less a summary of the expected effects of a concrete development program than they are a statement of the objectives to be sought in future formulation of programs. In this respect they are not particularly useful for present consideration.

On the other hand, because the Seven Year Plan has been worked out now in terms of specific investment programs and plans for technical advances, it is worthwhile examining it in greater detail. In Table 1* the implied labor savings from changes in productivity in Soviet industry during the Seven Year Plan are summarized on the basis of the output targets and the planned change in output per wageworker. In terms of fixed capital per wageworker (see Table 3**), the five most labor-intensive branches of industry are light industry; wood, paper, and allied products; machine building and metal working; construction materials; and the food-processing industry. In 1958 these five industries employed 76 percent of the industrial wageworkers. During 1959-65 they are expected to achieve 77 percent of the total labor savings. As a result of relative differences in the rate of growth in output and in labor productivity, their share of the total employment should decline slightly to 74 percent in 1965. Although this decline does not seem very marked, it does mean that one-third of the increment in employment during 1959-65 will be allocated to the capital-intensive industries, which in 1958 employed only one-fifth of the labor force.

D. Some Significant Trends, 1959-65

From the available Soviet plan data, several important conclusions may be drawn, as follows:

1. Approximately three-fourths of the total reduction in requirements for wageworkers in industry is to come from the most labor-intensive branches and in large part as the consequence of labor-saving measures of mechanization and organizational change.

2. Among the branches of industry a larger share of the net additions in the employment of wageworkers is to be directed toward branches requiring greater skills in labor than are usually required in the labor-intensive branches.

* Table 1 follows on p. 15.
** P. 25, below.

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Table 1

USSR: Employment of Wageworkers and Implied Labor Savings from Change in Productivity, by Branch of Industry, a/ for the Seven Year Plan (1959-65)

Branch of State Industry	1965 Indexes (1958 = 100)		Employment (Thousand Persons) b/				
				1965		1959-65	1959-65
	Production	Output per Worker	1958	If No Change in Productivity	If Change in Productivity	Implied Labor Saving	Increase in Implied Employment
Total industry c/	180	145 to 150 c/	16,279	29,302	19,866	9,436	3,587
Aggregate of branches				29,491	19,044	10,447	2,765
Machine building and metalworking	188	170	4,932	9,272	5,454	3,818	522
Light	150	136	2,515	3,772	2,774	998	259
Wood, paper, and allied products	159	153	2,252	3,581	2,341	1,240	89
Food processing	172	150	1,649	2,836	1,891	945	242
Construction materials	250	160	1,072	2,680	1,675	1,005	603
Coal	123	130	1,071	1,317	1,013	304	-58
Chemical	300	150	700	2,100	1,400	700	700
Ferrous metallurgy d/	160	145	678	1,085	748	337	70
Nonferrous metallurgy	200	180	400	800	444	356	44
Electric power e/	240	190	222	533	281	252	59
Oil and gas f/	250	150	138	345	230	115	92
Other g/	180	147.5	650	1,170	793	377	143

b. Data are for average annual employment of wageworkers in industrial production and exclude salaried employees and employment in industrial cooperatives. Labor savings have been calculated according to the equation given in Appendix A.
c. The Soviet announced goal for output per worker in industry during 1959-65 is an increase of 45 to 50 percent. The midpoint of this range has been used for calculations including the "other" category.
d. Data [redacted] include wageworkers in ore mining.
e. Centralized electric power only, excluding distribution.
f. Production and refining only.
g. The "other" category in almost every case is a residual or average category and, as such, it is subject to a greater degree of inaccuracy than the categories where more detailed and specific information is available.

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3. Within branches, there will be shifts in requirements for training and education as manual labor is eliminated in large part and as the need increases for workers who can supervise and service the new machinery.

According to a recent survey, in mid-1959, 47 percent of the Soviet industrial workers performed a significant amount of manual labor. 9/ Fulfillment of plans for mechanization will displace most of these laborers and necessitate training them for other jobs. At the present time, one-third of the industrial workers have had training equal to some high school education or higher. 10/ In December 1960, 494,000 specialists with a college education or higher were employed in industry, including 377,000 engineers. A large part of this total was employed in machine building -- 224,000 specialists including 178,000 engineers. 11/ During the period of the Seven Year Plan it is planned that the number of industrial specialists with a college education or higher be increased by 50 percent above the number in 1958 and the number of engineers employed by industry be increased 70 percent. 12/ Such personnel usually are salaried employees, and it is significant that these increases are much higher than the increase of about 20 percent in employment of industrial wageworkers (see Table 1).

4. The greatest gains in productivity are to be realized in the following industries (see Table 1): electric power, nonferrous metallurgy, machine building and metalworking, and construction materials. In the latter three, programs of mechanization and the introduction of more productive machinery play an important role; in the former, great weight is being attached to automation even though most of the labor saving results from economies of scale from using larger, more productive units of equipment.

5. The potential gains from the mechanization of materials handling, plant transport, and storage operations are very large. In 1958, 3.69 million wageworkers in Soviet industry were employed in such functions, and 70 percent of these were employed in the five most labor-intensive industries. 13/

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6. Soviet writers have estimated the relative magnitudes of the main factors for increase in industrial labor productivity, although the methods of calculation are sometimes arbitrary. Thus Aganbegian writes that industrial labor productivity is to increase 34 to 37 percent because of the introduction of new equipment, new technology, new procedures, and specialization and that it is to increase 11 to 13 percent because of factors relating to the quality and nature of the labor force. 14/

A Gosplan study in 1959 concluded that the possibilities of increase in labor productivity had been underestimated in the Seven Year Plan. This study stressed the importance of factors that did not involve the supply of new equipment. Thus it found that improved organization of production and labor will account for the following shares of the total increase in labor productivity: in ferrous metallurgy, 24 percent; in machine construction, 32 percent; and in chemicals, 22 percent. This study relates only 60 percent of the total increase in labor productivity in industry to capital investment in equipment and technology.* 16/

By implication, approximately 60 percent of the total labor saving of about 10 million wageworkers would be attributable to the use of new equipment and to technological changes. Of these 6 million, almost 2 million would be freed through the mechanization of materials handling work. 17/ Mechanization of a large part of the operations now performed manually and the acquisition of more productive equipment, either new or modernized, will account for most of the labor savings attributable to capital formation. There does not appear to be any basis to expect any acceleration in technical progress before 1965 from applications of automation in the industrial economy. But if a serious effort is made to achieve the goals for industrial output and labor productivity for 1980, there are major implications for the level of technology that must be achieved. It is too early to judge the reality of these goals and the feasibilities of programs that have not been worked out yet in detail.

Much of the preceding discussion has been in terms of plans for a total change in labor productivity. Now it will be useful to examine

* This figure may be equivalent to another statement that expenditures for equipment, mechanization, and automation in industry would lead to an increase of 30 percent in labor productivity; this statement was based on a survey of 11 branches of industry with an implicit employment of more than one-half of industrial employment. 15/

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the plans for capital investment during 1959-65 in order to estimate the capital investment required to displace a worker in each of the various branches of industry or conversely the planned increase in capital per worker needed to facilitate the planned increase in labor productivity. From these estimates, some judgment can be made concerning the degree of substitution of capital for labor that has already occurred in the various branches of Soviet industry and the extent to which labor productivity depends on capital investment.

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III. Technical Change and Capital Formation

A. Capital Cost of Programs for Technical Advances

The chief instrument of production has become the machine, directed ultimately by man. During the period of the Seven Year Plan the total expenditures for the acquisition of machinery for the state sector of the economy will be more than 60 billion to 65 billion rubles. 18/ Of this total, approximately two-thirds, or some 40 billion rubles, are for equipment to be used in industry.*

Various Soviet writers have made ambiguous statements about the total capital investments in "integrated mechanization and automation" during the Seven Year Plan. One source states that the "principal measures" will cost 10 billion rubles, a figure apparently not limited to industry. 20/ Another says that the total will be "more than 10 billion rubles" and in the context implies that this total also includes some expenditures in the nonindustrial branches, including agriculture and transportation. 21/ Another states that in 11 major branches of industry, 7.6 billion rubles will be spent. 22/ From these statements it seems reasonable to expect that "expenditures for complex mechanization and automation" in all industry will amount to 7.6 billion to 10 billion rubles, or somewhat less than one-fourth of the total expenditures in industry for equipment.

It is not clear just what kinds of equipment are being procured in this category of "expenditures for complex mechanization and automation." One likely hypothesis would be that the category covers all expenditures for instrumentation, control devices, servomechanisms, computers, and hoist-transport equipment (including conveyors and materials handling equipment).

This hypothesis may be checked for consistency against what is known about production of these lines of equipment. Thus the total production of "instruments and the means of automation" is planned to total 9.3 billion rubles during 1959-65, slightly more than one-half of which, 23/ or 4.7 billion rubles, would be for industry. The total production of hoist-transport equipment during 1959-65 is valued at 2 billion to 3 billion rubles, although not all of this equipment is designated for industry. Expenditures on these two categories of equipment solely for industrial use would amount to about 6 billion to 7 billion rubles. The total expenditures probably would include certain types of

* In 1959 an estimated 41 percent of industrial capital investment went for equipment. 19/

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automated equipment, such as automatic lines (worth 0.14 billion rubles 24/) and perhaps various expenditures on the "experimental model plants," of which there are 81. 25/ It does not appear that this particular hypothesis can be established firmly, but at least it is not inconsistent with the facts.

B. Capital Investment and Increases in Labor Productivity

Conceptually the USSR could have planned to achieve the output goals for 1965 by proportionate increases in labor and capital (fixed assets). As already seen in the preceding section, the increase in industrial employment during the period of the Seven Year Plan is to be less than proportionate to the increase in output. In this section the investment plans will be considered to see whether or not and to what extent they deviate from such proportionality. Theoretically a more than proportional increase in capital might be expected to make up for the labor saving. It is also to be expected that there would be some basic uniformity (roughly equivalent to the uniformity of wage rate) as between industries in the amount of above-norm investment made to save a worker and that lower-than-norm investment per worker saved in any particular industry would be some gauge of the more rapid technological gain in that industry.

The USSR plans to invest 104 billion rubles in industry during the 1959-65 period. The replacement value of fixed capital at the beginning of the period was estimated to be about 70 billion rubles. A planned increase in production of 80 percent would have required a theoretical net increase of 56 billion rubles in fixed assets. Because more than a proportionate share of the increase in production is to take place in industries with a higher share of capital than of value of output, the application of the varying increases in production to fixed assets of each industrial sector shows that the increased capital requirements total 64.3 billion rubles if the capital/output ratio of each industry is to be maintained. From the 104 billion rubles of investment, provision first must be made for the replacement of fixed assets estimated at 15.7 billion rubles to be retired during the Seven Year Plan to determine the net increase of fixed assets, which is 88.3 billion rubles. Deducting the 64.3 billion rubles required to maintain the capital/output ratio of the component industrial sectors leaves a residual "above-norm" investment of 24.0 billion rubles. Thus the first expectation of an increase in capital more than proportional to the increase in output is fulfilled. It remains to be seen, however, whether the "above-norm" investment can be directly related to labor saving.

The detailed distributions of investment by industrial sector are shown in Table 2.* In order to facilitate subsequent thinking about

* Table 2 follows on p. 21.

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Table 2

USSR: Industrial Investment, by Branch of Industry, for the Seven Year Plan (1959-65)

Branch of State Industry	Billion Rubles a/					
		Investment Required to Maintain 1958 Capital/Output Ratios				
	Gross Capital Investment b/	Retirements	To Equip New Workers	Available to Increase Capital per Worker	Investment Available to Increase Capital/Output Ratios	Ratio of Added Investment to Labor Savings (Thousand Rubles a/ per Worker)
Total industry	104.0	15.68	14.89	49.45	23.98	2.30 c/
Machine building and metalworking	11.8	2.86	1.60	11.71	-4.37	-1.14
Light	3.3	0.66	0.34	1.30	1.00	1.00
Wood, paper, and allied products	5.8	0.91	0.16	2.29	2.44	1.97
Food processing	4.7	1.26	1.00	3.92	-1.48	-1.57
Construction materials	7.7	0.91	1.96	3.26	1.57	1.56
Coal	7.5	1.32	-0.34	1.79	4.73	15.56
Chemical	10.0	0.94	2.93	2.93	3.20	4.57
Ferrous metallurgy	10.0	1.50	0.69	3.33	4.48	13.29
Nonferrous metallurgy	5.5	0.70	0.31	2.51	1.98	5.56
Electric power	12.5	1.87	2.21	9.41	-0.99	-3.93
Oil and gas	17.0	1.47	2.76	3.45	9.32	81.04
Other	8.2	1.28	1.27	3.55	2.10	5.57

a. 1955 rubles converted to new rubles established by the Soviet currency reform of 1 January 1961.
b. Where the planned investment in an industrial sector has been announced as a range, the lower of the range has been used. Had the upper limit been used instead, 2.4 billion rubles additional would have been distributed by the industrial sector, and "other" would have dropped to 5.8 billion rubles.
c. Derived as the quotient of the sum of the added capital investment of the individual branches divided by the sum of the labor saving of the individual branches.

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the increase in fixed assets per worker employed, the investment required to maintain the capital/output ratio of the component industrial sectors has been subdivided into that which equips new workers to the level per worker in 1958 and that which is planned to go to increasing the capital per worker. The result of this analysis is to distribute the investment as follows:

	Billion Rubles
Total	104.00
Estimated requirements to replace the assets retired	15.68
Estimated requirements to increase the fixed assets of each industrial component in proportion to output	64.34
Including:	
To equip new workers planned to be employed	14.89
To increase capital per worker	49.45
Estimated additional investment that raises both capital per worker and capital/output ratios	23.98

In Table 2* the 23.98 billion rubles of investment available to substitute for labor have been divided by the labor saving shown in Table 1.** It would have been very easy to conclude that the Soviet planners expected to displace about 10 million workers for the additional investment of 24 billion rubles and therefore placed a value of about 2,300 rubles on each displacement. Upon looking at the individual industrial sectors, however, a wide variation is found. The additional planned investment per worker displaced ranges from a negative 3,900 rubles in the electric power industries to a high of 81,000 rubles in the oil and gas industry. If those industries in which planned investment is less than that required to maintain the capital/output ratio -- food processing, electric power, machine building and metalworking, and "other" industries -- are left out of account, 28.7 billion rubles are planned to be invested to displace 5.1 million workers, or some 5,700 rubles per worker displaced. The range is only slightly narrowed -- from 1,000 rubles in light industry to the 81,000 in the oil and gas industry. Any search for some rough uniformity in investment per

* P. 21, above.
** P. 15, above.

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worker saved and a consequent ability to detect deviations from that standard is therefore not crowned with success.

A number of considerations in fact preclude the determination of a capital-labor substitution ratio or any final conclusions about the introduction of technology from the data in Table 2.* For example, in the oil and gas industry, planned investment includes construction of pipelines for transporting petroleum, but in the base period the investment and any workers to be displaced were in the transportation sector, not in industry. Conversely, in the case of coal, high cost (and hence by definition high-value output** of brown coal in the Moscow Basin and in the Northern Urals) is to be reduced and replaced by low cost - low value production of better steam coal in more remote fields such as at Ekibastuz. The result will be cheaper and better fuel to the consumer but with a large part of the final value credited to output of transportation and a smaller part to the coal industry. Much of the required investment in the Seven Year Plan is in the coal industry rather than in transportation facilities that were built in preceding plan periods. In the case of electric power a large part of the planned investment is for the purpose of raising the relation of capacity to output. In other words, investment per unit of capacity is going down but, measured in terms of output in 1965, is increasing because the plan calls for a reduction in the hours of use. Reductions in the hours of use -- or increased standby capacity -- together with large investments to be made in the distribution system will provide safeguards against interruptions in electric service that have high real value. Certainty of service is not normally fully reflected in the value of output, because it relates to quality rather than quantity of service. Planned investments in ferrous and nonferrous metallurgy are complicated by the necessity to process lower grade ores and to improve the finishing of metal. Capital saving improvements in blast-furnace and refining technology such as the larger furnaces with oxygen and natural gas injection to be used in the steel industry are obscured by the large investment in mining and beneficiating low-grade ores.

Even in the case of the food-processing and machine building and metalworking industries, where there is clearly a planned saving both of capital and of labor in relation to output between 1958 and 1965, there is no way to determine from the gross data the extent, if any, to which such saving should be attributed to payoff on past investments or conversely to the introduction in the period of new technologies. In the case of machine building and metalworking, there is a growing suspicion that the fixed asset data and investment plans do not include those for facilities producing military equipment, whereas in the labor force data those employed in such production are counted in this sector.

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* P. 21, above.

** Soviet plan data are in terms of gross value of output, which in most cases varies directly as production cost.

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All of the industrial sectors contain such a heterogeneity of activities as to necessitate a much closer look at the component branches than is possible here prior to any final judgments on the effect of planned changes in technology on investment requirements.* Along such lines it would be of interest to examine the association between the growth of fixed capital and increases in labor productivity for individual branches of industry in recent years. Time series data for the fixed capital of individual branches, however, are very scarce, and more research is required. Such research is now underway.

Bearing in mind the necessity for more detailed subsectoral analysis before final conclusions can be drawn, it is nevertheless of interest to compare the planned rate of growth of assets per worker with the planned rate of increase in output per worker. The estimated value of assets per worker at the end of 1958 and 1965 in thousands of rubles and as an index with 1958 as a base is shown in Table 3.** The value of assets used here is conceptually the undepreciated replacement cost as of 1955 of all assets used and useful in the industry as inventoried by the USSR at the end of 1959 moved back to 1958 and forward to 1965 on the assumption that the planned investment of the Seven Year Plan will be made in increasing increments starting at 10 percent of the planned investment in 1959 and about double that in 1965. Allowance also has been made for assets estimated to be physically retired in the 1959-65 period (see Table 4, Appendix A***).

For industry as a whole the value of assets per worker is planned to increase from 4,290 rubles to 8,310 rubles, or by 94 percent. In five of the industrial sectors -- oil and gas, electric power, coal, ferrous metallurgy, and nonferrous metallurgy -- the investment per worker in 1958 was above the average for all industry. In each of those industries, except electric power, the increase in assets per worker is planned at a greater rate than for all industry. Assets per worker in the chemical industry are planned to more than double and will move from just below the industrial average to just above it. On the whole, however, those industries that had above-average capital per worker in 1958 are planned to have relatively more capital per worker in 1965. Leaving out the "other" category -- which is subject to the compound errors of all residuals -- the electric power industry had 29 times the capital per worker of light industry in 1958. According to plan, by 1965 the disparity will have grown somewhat, with the oil and gas industry having more than 40 times the capital per worker of light industry and the electric power industry about 32 times. In other words, there is a clear tendency for the most capital-intensive industries to grow even more so.

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** Table 3 follows on p. 25.
*** P. 40, below.

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Table 3

USSR: Comparison of Change in Fixed Capital per Worker and Output per Worker, by Branch of Industry, for the Seven Year Plan (1959-65)

Branch of State Industry	Fixed Capital per Worker (Thousand Rubles) a/		1965 Indexes (1958 = 100)		
	1958	1965	Fixed Capital per Worker	Output per Worker	Capital/Output
Total industry b/	4.29	8.31	194	145 to 150	125
Machine building and metalworking	3.07	4.41	144	170	85
Light	1.30	2.13	164	136	121
Wood, paper, and allied products	1.84	3.86	210	153	137
Food processing	4.15	5.44	131	150	87
Construction materials	3.25	6.13	189	160	118
Coal	5.89	12.33	209	130	161
Chemical	4.19	8.56	204	150	136
Ferrous metallurgy	9.88	20.32	206	145	142
Nonferrous metallurgy	7.05	17.16	243	180	135
Electric power	37.39	67.37	180	190	95
Oil and gas	30.00	85.52	285	150	190
Other	8.88	16.00	180	147.5	122

a. 1955 rubles converted to new rubles established by the Soviet currency reform of 1 January 1961.
b. All data for total industry are aggregates of branches except the official plan for output per worker (see the discussion on p. 11, above).

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When the planned increase in capital per worker is compared with the planned increase in output per worker, capital rises more rapidly. There are three exceptions noted above -- the food-processing industry, the electric power industry, and the machine building and metalworking industry, in which labor productivity is expected to rise more rapidly than the capital per worker. On the basis of the six industrial sectors in which capital per worker is planned to exceed the average in 1965 the index of capital per worker ranged from 180 to 285, whereas for the other five sectors it is only 131 to 210. For the same two groups, there is no corresponding discrepancy in the index of output per worker, which ranged from 130 to 190 for the first group and 136 to 170 for the second. There is a strong implication, therefore, that the ratio of capital to output is rising more rapidly in the first group than in the second.

It should be pointed out that the five industrial sectors that will have below-average capital per worker in 1965 employed 76 percent of the industrial labor force in 1958 but had only 47 percent of the fixed assets in that year. During the Seven Year Plan, only 32 percent of the planned investment is scheduled for those industries, but they will nevertheless contribute about three-fourths of the reduction in labor requirements resulting from planned increases in labor productivity. Because the planned labor saving is so high in relation to the modest capital investment, it is apparent that gains in labor productivity will result from several factors of varying importance, including gains arising from organizational and administrative measures -- particularly the more even flow of materials; the improvement of plant layout; the addition of instrumentation; and the extension of mechanization, especially in materials handling.

In the six industrial sectors that will have above-average capital per worker in 1965, 20 percent of the industrial workers utilized 45 percent of the fixed assets in 1958. By 1965 these same six industries are planned to have more than half of the industrial fixed assets and only about one-fifth of the workers. The growth of output in these industries is clearly associated with extensive additions to fixed capital. It is not surprising, therefore, that these are the industries most often mentioned in the context of eventual applications of forms of automation involving capital saving.

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IV. Problems of Planning Equipment Supply and Technical Changes

A. Shortages of Equipment

Although various Soviet authorities have complained about a lack of initiative on the part of plant managers with reference to the installation of new equipment where feasible and appropriate, the facts indicate that orders for equipment exceed production, that deliveries have fallen behind schedule, and that it has been necessary to increase output of equipment faster than originally planned in the Seven Year Plan.

The mechanization of materials handling, for example, is a very inexpensive way to get gains in labor productivity. Yet in 1957-58, shortages of hoist-transport equipment made it necessary to increase the number of railroad loaders by 40,000 in the RSFSR. In 1959, output of hoist-transport equipment in the economy satisfied only 40 to 50 percent of demand (in the sense of requests for delivery of equipment). 27/ There are still numerous complaints of inadequate increase in production of this equipment. 28/ In 1959, delayed delivery of equipment and the failure to produce some necessary models of equipment led to nonfulfillment of a large number of the assignments for automation. 29/

Production has lagged behind requests for delivery in many lines of equipment, including various models of chemical equipment 30/; radio tubes 31/; office machines 32/; instruments and equipment for automation 33/; petroleum equipment 34/; forge-press equipment 35/; nonstandard equipment for nonferrous metallurgy 36/; equipment for the coal industry 37/; food-processing machinery 38/; textile machinery 39/; equipment for the logging, wood, and paper industries 40/; construction equipment 41/; and equipment for the cement industry. 42/ In this connection, a Soviet industrial economist has stated: "There is no branch of heavy and light industry which has not presented and which will not present serious demands on our machine construction industry to insure supply of more modern machines, mechanisms, and instruments. The tasks of machine construction in this relation are enormous." 43/ In order to meet this demand, the expansion of the machine building industry is being accelerated beyond the original pace of the Seven Year Plan.

B. Criteria for Decisions on Investment as a Cause of Shortages of Equipment

The problems besetting those who plan production and allocation of equipment have been widely discussed in Soviet publications. In large part the problems stem from difficulties in forecasting the demand for equipment and rest upon biases in investment criteria used in the USSR.

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To clarify this point, it is necessary to summarize some of the steps in supply procedure. For any given planning period the plant managers are given approved targets for production, for assortment of products, and for reduction in costs. On the basis of these targets they estimate their equipment requirements for the planning period and after approval submit equipment orders to the supply organizations. These supply organizations place purchase orders with the enterprises producing equipment, and should the latter not have the production capacity to satisfy immediate demand, the supply organizations allocate the available production according to the priority of the requesting plant. The supply organizations dealing with the more important lines of equipment notify Gosplan of any outstanding supply deficits, and Gosplan then takes measures to improve the supply.

If production of equipment could be adjusted promptly in response to changes in the demand for equipment, the problem would be slight. But this is not the case, for to increase production of any given item in an economy operating at full capacity would involve the diversion of capacity from other production (either creating new production capacity or transferring capacity from other uses as an interim measure) directly or for creating new production capacity for the item. Creating new capacity may involve a time lag; transferring capacity directly may produce complications in the supply of some other important equipment item.

If demand could be centrally planned and regulated, ex ante, there would be no problem at all. But this situation would defeat the basic concept of the Soviet approach toward the achievement of technical advances -- that is, the encouragement of the adoption of improved production practices on the initiative of those who know the most about the opportunities, the managers and the workers.

If the proper investment criteria were made available to the plant managers, there would still be some problem in planning production to satisfy the demand for equipment as derived from the individual investment decisions, but there would be little likelihood of any general imbalance between demand and supply of equipment. But there are some Soviet economists who question the adequacy of the present investment criteria and imply that there might indeed be chronic imbalances. This situation is especially true in those cases where the planning price for equipment in deficient supply is kept low. 44/

The full argument for the possibility of chronic supply problems is not developed by any Soviet economist, although it is hinted at by several. The implicit case is summarized briefly as follows. The basic premises to the case are four: (1) that the Soviet concept of value (stoimost') is strongly biased toward consideration of labor inputs

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while denying any scarcity value to capital inputs; (2) that efficiency changes are measured in terms of reduction of stoimost' (and thus primarily in terms of changes in labor productivity); (3) that Soviet pricing policy is dictated by considerations of income distribution rather than the efficient allocation of scarce resources;* and (4) that the opportunity cost arising in the use of scarce capital resources is not fully included in the costing of goods produced with the use of scarce capital. If these statements are true, one would expect to find empirical evidence that the substitution of capital for labor is carried too far, given the available resources of each; that the demand for many types of equipment exceeds the supply (evidence would be the rationing of new equipment and delays in the supply of equipment to users); and that the output plans tend to favor the growth in output of products that are capital-consuming relative to the labor inputs (oil, electric power, and the like). Furthermore, if the hypothesis is true, the pressures to increase the share of capital investment within the uses of national income would be quite severe.

As the USSR increases its capital resources relative to its labor resources, it is to be expected that the wage level will rise relative to the unit costs of capital investment and that the cost of construction (which has a large wage component) will rise relative to that of equipment. Any biases in the Soviet pricing system would tend to intensify these tendencies, some of which are illustrated below in the tabulation on changes in the relative costs of equipment, construction, and wages in the USSR 45/:

Index	1960 Index (1950 = 100)
Equipment unit costs	67
Construction estimate costs	92
Average money earnings of workers and employees (estimate of this Office based on Soviet source material)	128
Average money earnings in industry	129

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* Hence the prices of new technical equipment are to be kept low to encourage the purchase of the equipment by plant managers. The economic gains are thus to be passed on to the using plant rather than to the firm producing the equipment (which loses a source of capital for the needed expansion of output).

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These indexes show that, during the last decade, there indeed have been cost movements decreasing the cost of equipment relative to the cost of construction, which is strongly influenced by trends in the wage level. The expected result would be to stimulate the demand for equipment as against the demand for construction, which could take such form as an intensified emphasis on reequipping existing plants in preference to building new plants. Soviet statistics demonstrate, however, that the share of equipment in the total capital investment fell at the time of the Korean War, rose again during 1954-56, and fell again during 1957-60. 46/ The latter decline is difficult to explain, although part of the explanation lies in the emphasis on housing construction during these years that tended to increase the relative share of construction in the total capital investment and although part lies in problems that appear to be associated with the supply of equipment because the plans for acquisition of equipment were not fulfilled during several of these years.

C. Equipment Supply for Priority Projects

On the supply side, there has been a significant trend toward centralization of the responsibility for supply of equipment for priority projects. In the 1961 Plan, 434 construction projects were designated as of national priority (osobo vazhnyy), and there was to be centralized allocation of equipment to 613 enterprises.

A new system of supply organization is being developed in conjunction with the supply of equipment to priority consumers. In a sense the new organizations are an outgrowth of the industrial reorganization of 1957, which created a problem of coordinating supply flows among the new Councils of National Economy and among republics.

On the All-Union level the keystones of the new supply organization are five outfitting administrations under Gosplan USSR -- the glavkomplekty. On behalf of priority customers, for a list of equipment, instruments, and cable allocated on an All-Union basis, the outfitting administrations screen requests, place production orders, and oversee delivery. Similar outfitting administrations exist at the Republic level and supervise supply of priority items under supply procedures centralized at the Republic level. 47/ To date, the coordination between these organizations has been relatively poor, and their operations have not been of spectacular success. Nevertheless, the outfitting trusts are in a position to become the vital link in coordinating the planning of production of equipment with the equipment requirements of the plans for technical advances. 48/

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D. Planning and Administrative Framework for Technical Advances

During the last 6 years the emphasis of the regime on raising the level of production technology has shifted from the concern expressed in 1955 over the backwardness of Soviet industry, construction, and transport (see the speech by N.A. Bulganin in 1955 49/) to a more positive emphasis on the opportunity provided by technical advances for realizing output targets more rapidly. 50/ This shift from gloom to hope is largely psychological in nature, resting on a new pride in Soviet scientific achievement characteristic of the post-sputnik era but supported only modestly by the actual implementation of plans for technical advance. Serious problems have been encountered in the expansion of the chemical industry, in the design of economical plants utilizing nuclear energy for production of electric power, in the construction of adequate secondary refining capacity for oil, and in the addition of plant capacity for processing complex nonferrous ores. On the positive side, there have been some significant successes in strengthening the capabilities of ferrous metallurgy and in the development of a more rational (that is, less expensive) fuel and energy base for the economy. 51/

During this transition period, covering 1955 to date, there has been extensive experimentation in the forms of organization of governmental and Party control over the planning and execution of measures for technical advances. In response to the charge that weak leadership on the part of ministers and heads of departments was a major cause for the unsatisfactory execution of plans for the introduction of new equipment into the national economy*, in 1955 the State Committee of the Council of Ministers for New Techniques (Gostekhnika) was formed as a centralized federal agency with broad powers of planning, control, and inspection. 53/

With the reorganization in 1957 of the Soviet economy into a system based on regional planning units (the Councils of National Economy) rather than ministries, Gostekhnika could not survive, because its operation was based on a ministerial system centralized in Moscow. 54/

Following the reorganization the responsibility for charting the course of technical development within Soviet industry has not been tightly held within any single governmental agency. Rather, it is characteristic in recent years for plenary sessions of the Central Committee of the Communist Party to assign various aspects of the planning responsibility to Gosplan, Gosekonomsovet, the State Committee for Automation

* This charge was openly made in Bulganin's speech in July 1955 but may have prevailed earlier and may have been instrumental in the formation of Gostekhnika in May 1955. 52/

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and Machine Building (GKAM), the State Scientific-Technical Committee (GNTK) (now defunct) and to detail specific tasks to other agencies such as the various State Committees concerned with industry, with construction, and with labor and wages.* The Academy of Sciences has played an important role in preparing perspective planning studies, performing research and development assignments, and providing skilled personnel to the line governmental agencies for planning assignments. Within the Central Committee of the Party and the governmental bodies it may be possible to identify some members of the Central Committee as being specifically interested in topics related to technical change.**

It now appears that recently there may have been some competition between Gosekonomsovet and the GNTK for a position of predominance in technical planning. Gosplan has lost most of its long-term planning function to Gosekonomsovet, although a recent revision of the organization of technical supply has given Gosplan an important operative responsibility in technical planning. The GKAM has major planning responsibilities, but its sphere is relatively limited -- that is, to applications of automation in the economy and to technical advances in machine building.

The GNTK had been formally vested with the authority to control and to supervise the development and introduction of new technology in the Soviet economy, 57/ yet, because it was not granted significant operational powers, it had to function as a staff agency, supplying research facilities, publishing scientific information, and coordinating the activities of line organizations -- especially where interbranch and interrepublic activities were involved. 58/ Early in 1960 it was suggested authoritatively that its powers be broadened, at least in sufficient degree to permit overseeing the fulfillment of the plans adopted for the introduction of new technology. 59/

Rather suddenly, in April 1961, the GNTK was replaced at the All-Union level by a new State Committee for the Coordination of Scientific Research. The new committee was given greater powers to coordinate scientific research. It was not, however, chartered as an organization to plan technical advance as such in the economy. Rather, coordination of research and economic planning would be insured through the participation of the Deputy Chairman, respectively, of Gosplan and of Gosekonomsovet in the new committee. 60/

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** Thus Koslov, Kosygin, and A.P. Rudakov, the latter being head of the Heavy Industry Section of the Central Committee, were prominent among scientific and planning personnel at the funeral of M.I. Antipov, who headed the scientific research institutes under Gosekonomsovet. 56/

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Actual authority for any operational planning in the area of technical advance appears to rest with the normal All-Union and republic planning authorities, the Councils of National Economy, Gosplan, Gosekonomsovet, and the other organizations associated with production planning. Given this structure, it is not possible to speak of any single agency fully responsible for operational planning of technical advance. In fact, Soviet experts observe that the demise of Gostekhnika in 1957 represented the end of technical management by a single Federal organ. 61/

In the pattern of decentralization of responsibility for technologic advance the plan for the introduction of automation and integrated mechanization emerges as an exception. In this case, there seems to be a greater degree of advance administrative planning (largely in the State Committee for Automation and Machine Building) and more feeling that the possible social and economic effects will be of such scope as to require advance planning.

Planning without some means of control over performance is ineffectual. In an administered economy the basic controls are administrative. In the USSR, there is in being an elaborate system of administrative control over the execution of the national economic plans, but a large body of evidence suggests that the Party does not consider the system to be particularly effective in dealing with the stimulation of technical change, suggesting in turn that new forms of administration and control will be developed.* Careful evaluation of new measures to increase control over execution of technical programs and to heighten incentives to improve technical performance as they develop will cast some light on both the Soviet objectives and the degree of success in achieving the desired improvement in technology.

* At the date of the publication of this report a new reorganization of Soviet industry is being undertaken, an important characteristic being a return to greater centralization of control over the planning for the introduction of new technology.

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V. Preliminary Evaluation of the Impact of Technical Changes on Future Soviet Industrial Growth

Maintenance of a high rate of increase in industrial labor productivity will be made possible by programs to train the labor force to the qualifications needed by the newly mechanized economy, to utilize labor more effectively, to supply the labor force with more productive machinery, and to improve industrial organization to take greater advantages of the economies of scale. On the other hand, industrial growth is becoming increasingly dependent on the expansion of fixed capital resources and on the introduction of advanced technology.

The Soviet government is devoting resources and efforts to industrial development on such a scale that it seems reasonable to conclude that a high rate of increase of labor productivity will be maintained during the next 5 and possibly the next 10 years. There is no evidence of any immediate likelihood that new developments in technology will permit an acceleration in the rate of increase of labor productivity during this period.

Soviet industrial labor productivity, in spite of its rapid rise, lags behind that of the US and Western Europe. It may be argued that the rapid advances in recent years represent the inevitable outcome of the large Soviet investment program and the relative availability of advanced Western technology for Soviet utilization but that the rate of change in productivity must taper off as Soviet labor productivity reaches Western levels. On the other hand, Soviet long-term plans postulate a continuation of the rapid growth of labor productivity and apparently are based on a premise that Soviet research and development efforts will provide an adequate basis for technical changes. This issue is quite basic to any analysis of Soviet growth and must be the subject of intensive research.

In all economies the most immediate incentive to technical improvement is one of cost-minimization in industrial development plans. In all economies the social and personal consequences of automation are profound. The Soviet planners hope that a high rate of growth will permit avoidance of any high degree of frictional unemployment through absorption of labor into the general industrial expansion. They do not ignore, however, the heavy requirements for educational advance and for the retraining of workers.

The problems faced by the US of accommodating technical advances in an economy characterized by a moderate rate of growth may be faced some day by the USSR and cannot be dismissed as an intrinsic difference in the two systems.

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It remains to be seen how effectively the USSR can stimulate capital-saving technical change. Until now its capital-output ratios have continued to rise. If it cannot reverse this trend, it may find that consumption and investment will increase competition for resources; that the rate of economic growth eventually will be retarded; and that some of the technical problems of deceleration will arise, especially the problem of overcapacity in some industries. Although automation is potentially capital-saving in large part and although the successful introduction of such automation should have a beneficial effect on capital efficiency, the excessive emphasis of Soviet investment criteria on the labor-saving effects may prevent full achievement of feasible capital savings. It cannot be proved conclusively from the scanty data, but the possibility exists that many of the present difficulties in provision of equipment may originate in poor estimates by planners of the extent and types of equipment required to achieve the planned targets for productivity change.

In spite of the great amount of propaganda about applications of automation, the facts indicate that the most significant gains in labor productivity during the next 5 to 10 years will stem from replacing manual labor with machines and instruments and that the applications of computers in industrial production technology will occur on a very limited scale. In this period of time the mechanization of materials handling and the addition of instrumentation to industrial processes will have far more economic impact than the introduction of full automation. In addition, there will be significant productivity gains from measures affecting the organization of production and the efficiency of utilization of labor.

In the context of longer term estimates, beyond 10 years, great significance will attach to developments in the following areas:

1. The development of procedures and organizations for the purpose of planning, administering, and controlling long-term programs of technical advance.

2. The development of planning techniques to permit better balancing of the demand and supply of modern technical equipment.

3. The expansion of industrial research and development organizations to encourage development and application of indigenous technology.

4. The development of decision criteria and planning techniques to permit more efficient use of capital resources.

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It is by no means assured that the Soviet economy will solve these problems. Effectively to plan technical advance in the long-term plans, the old desire of the planner for a "safety factor" in his calculations must be overcome,* new mathematical planning techniques must be devised to cope with the many variables, and new data on trends of technical change must be made available to planners.

To improve planning in the supply of equipment, problems of industrial organization must be resolved. Especially, centralized controls over capital investment must be reconciled with decentralized control over production of equipment. Again, better planning techniques would be needed to permit more adequate advance forecasts of the structure of demand for equipment.

The greatest potential gains in labor productivity often lie in industries where the least priority has been assigned to the various scientific institutes concerned with process development. Resources assigned for the purpose of industrial research and development must be assigned to a broader range of industries.

The need to improve investment criteria has been chronic and has been recognized by the Soviet authorities. Yet the present criteria are inadequate until the price system becomes an allocative system rather than one primarily concerned with the administration of income flows.

Industrial development is the arena in which all aspects of economic life come into play and affect the final outcome -- the availability of resources, the objectives of development, the price system, the technical alternatives of production, the production schedule desired by those planning the economy. In its nature it is a complex topic and one for which all conclusions are tentative, subject to change as the variables change and as knowledge improves. Yet the industrial development of the USSR in future years will affect US national affairs and the lives of its citizens in numerous ways. For this reason, the topic must be studied, the data must be improved, better analytical techniques must be developed, and the development plans of the USSR must be continuously evaluated in detail.

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* As the Soviet economist Strumilin has observed, technical advances themselves have often been considered the safety factor that would permit fulfillment and overfulfillment of long-term plans. The more technical advances are built into the plans, the less they remain a safety factor (and the more the pressure for effective planning).

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APPENDIX A

METHODOLOGY

The estimate of labor saving is based on the assumption that the labor requirement in 1965 would bear, in the absence of change in productivity, the same relation to labor employed in 1958 as output in 1965 bears to output in 1958. The labor requirement in 1965 with no change in productivity has been estimated, therefore, by multiplying the labor force in 1958 by the 1965 index of production. The projected labor force in 1965 (including a change in productivity) has been estimated by dividing the labor requirement with no change in productivity by the 1965 index of productivity. Implied labor saving is the difference between the projected labor force and the labor requirement with no change in productivity. The labor saving may be calculated more directly by the following formula:

$$\text{Labor force in 1958} \times \text{index of production} \times \frac{\text{Increase of productivity}}{\text{Index of productivity}}$$

An estimated breakdown of gross capital investment during 1959-65 is given in Table 2.* The amount for retirements is taken from Table 4.** Investment required to equip new workers at the 1958 capital-output ratio was calculated for the branches of industry by multiplying the increase in employment (as shown in Table 1***) by the fixed capital per worker in 1958 (as shown in Table 3†). Total investment for industry was taken as the sum of the investment in the branches of industry. Investment available to increase capital per worker at the 1958 capital-output ratio was obtained by multiplying the fixed capital in 1958 (see Table 4) by the increase in production during 1959-65 (see Table 1) and subtracting investment to equip new workers. Investment for total industry was taken as the sum of the branches of industry.

Gross capital investment during 1959-65 less investment required to maintain 1958 capital-output ratios and excluding retirements equals investment available to increase capital-output ratios. The ratio of added investment to labor saving is the amount of investment available to increase capital-output ratios divided by the implied labor saving (as shown in Table 1).

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* P. 21, above.
** Table 4 follows on p. 40.
*** P. 15, above.
† P. 25, above.

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Table 4

USSR: Estimation of Industrial Fixed Capital, by Branch of Industry a/
Selected Periods, 1958-65

Branch of State Industry	Gross Capital Investment 1959-65 (Billion Rubles) b/	Data on Fixed Capital (Billion Rubles) b/					Fixed Capital per Worker (Thousand Rubles) b/	
		Inventory						
		31 December 1958 (Estimated)	31 December 1959 (Actual)	Retirements 1959-65	Net Investment 1959-65	Implied Stock 31 December 1965	1958	1965
Total Industry	104.0	69.86	78.89	15.68	88.32	158.18	4.29	8.31 c/
Machine building and metalworking	11.8	15.13	16.01	2.86	8.94	24.07	3.07	4.41
Light	3.3	3.28	3.55	0.66	2.64	5.92	1.30	2.13
Wood, paper, and allied products	5.8 6.0	4.15 4.13	4.65	0.91 0.92	4.89 5.08	9.04 9.21	1.84 1.83	3.86 3.93
Food processing	4.7 5.3	6.84 6.78	7.18	1.26 1.28	3.44 4.02	10.28 10.80	4.15 4.11	5.44 5.71
Construction materials	7.7 7.8	3.48 3.47	4.18	0.91 0.91	6.79 6.89	10.27 10.36	3.25 3.24	6.13 6.19
Coal	7.5 7.8	6.31 6.28	6.94	1.32 1.33	6.18 6.47	12.49 12.75	5.89 5.86	12.33 12.59
Chemical	10.0 10.5	2.93 2.88	3.87	0.94 0.96	9.06 9.54	11.99 12.42	4.19 4.11	8.56 8.87
Ferrous metallurgy	10.0	6.70	7.57	1.50	8.50	15.20	9.88	20.32
Nonferrous metallurgy	5.5	2.82	3.31	0.70	4.80	7.62	7.05	17.16
Electric power	12.5 12.9	8.30 8.26	9.39	1.87 1.88	10.63 11.02	18.93 19.28	37.39 37.21	67.37 68.61
Oil and gas	17.0 17.3	4.14 4.11	5.76	1.47 1.48	15.53 15.82	19.67 19.93	30.00 29.78	85.52 86.65
Other	8.2 5.8	5.77 6.02	6.48	1.28 1.19	6.92 4.61	12.69 10.63	8.88 9.26	16.00 13.40

a. Because of rounding, components may not add to the totals shown.
b. 1955 rubles converted to new rubles established by the Soviet currency reform of 1 January 1961.
c. Derived as the quotient of the sum of fixed capital of the individual branches divided by the sum of the employment of wageworkers of the individual branches.

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The calculations used in estimating fixed assets per worker in 1958 and 1965 for Table 3 are shown, inter alia, in Table 4.* The inventory of fixed capital at undepreciated replacement cost on 31 December 1959 and the planned gross capital investment during the period of the Seven Year Plan (1959-65) were officially announced. Wherever planned investment in a branch of industry was announced as a range, calculations have been made at both the upper and the lower limit of the range, although for simplicity of presentation only those based on the lower limit were used in Tables 2** and 3. Fixed capital on 31 December 1958 was estimated to be equal to fixed capital on 31 December 1959 less 10 percent of the planned investment during 1959-65 (to allow for investment made during 1959) plus 2 percent of the adjusted figure (to allow for plant and equipment retired during 1959.)

The amount of investment required to replace capital retired during 1959-65 has been calculated as 15 percent of the estimated fixed capital on 31 December 1958 plus 5 percent of the gross capital investment during 1959-65. This calculation approximates roughly the replacement of 2 percent of fixed assets annually. A study of Soviet amortization practices as yet unpublished discloses no branch of industry in which the composite rate of recovery of the value of fixed capital is set as high as 4 percent. The average life of the capital, therefore, is expected to exceed 25 years. Theoretically the capital to be retired this year is that installed 25 years (or more) ago. With the rate of investment doubling every 10 years, the theoretical value to be retired would not exceed 1.3 percent of the cumulative investment. While 25 years appears to be a rather long-life expectancy, two Soviet practices make it more than plausible. First, in Soviet industrial investment some 60 percent of the total is for construction, and 40 percent is for equipment. The Soviet tendency to use heavy structures, which would have an average life of at least 40 to 50 years in US practice, gives a great weight to long-lived items in the composite inventory. Second, the Soviet practice of planned capital repairs (for which a separate amortization account is accumulated) is deliberately designed periodically to restore equipment to its original condition and hence extend its useful life. The Soviet planners have indicated that during the Seven Year Plan the percentage of investment for structures will be reduced and the retirement of equipment for obsolescence will be expanded. Consequently, an estimate approximating 2 percent per year of the year-end inventory has been used for retirement of fixed capital. In order to simplify the calculation, however, 15 percent of the estimate of fixed capital in 1958 plus 5 percent of those to be added during the plan period has been taken for the estimate of retirements during the 7-year period.

* P. 40, above.
** P. 21, above.

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Net investment during 1959-65 has been estimated from the gross capital investment by subtracting retirements. Net investment plus the capital stock on 31 December 1958 gives the implied capital stock on 31 December 1965. Fixed capital per worker in 1958 and 1965 has been estimated by dividing fixed capital in 1958 and 1965 by employment (as shown in Table 1*) in 1958 and 1965 (including a change in productivity), respectively.

* P. 15, above.

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